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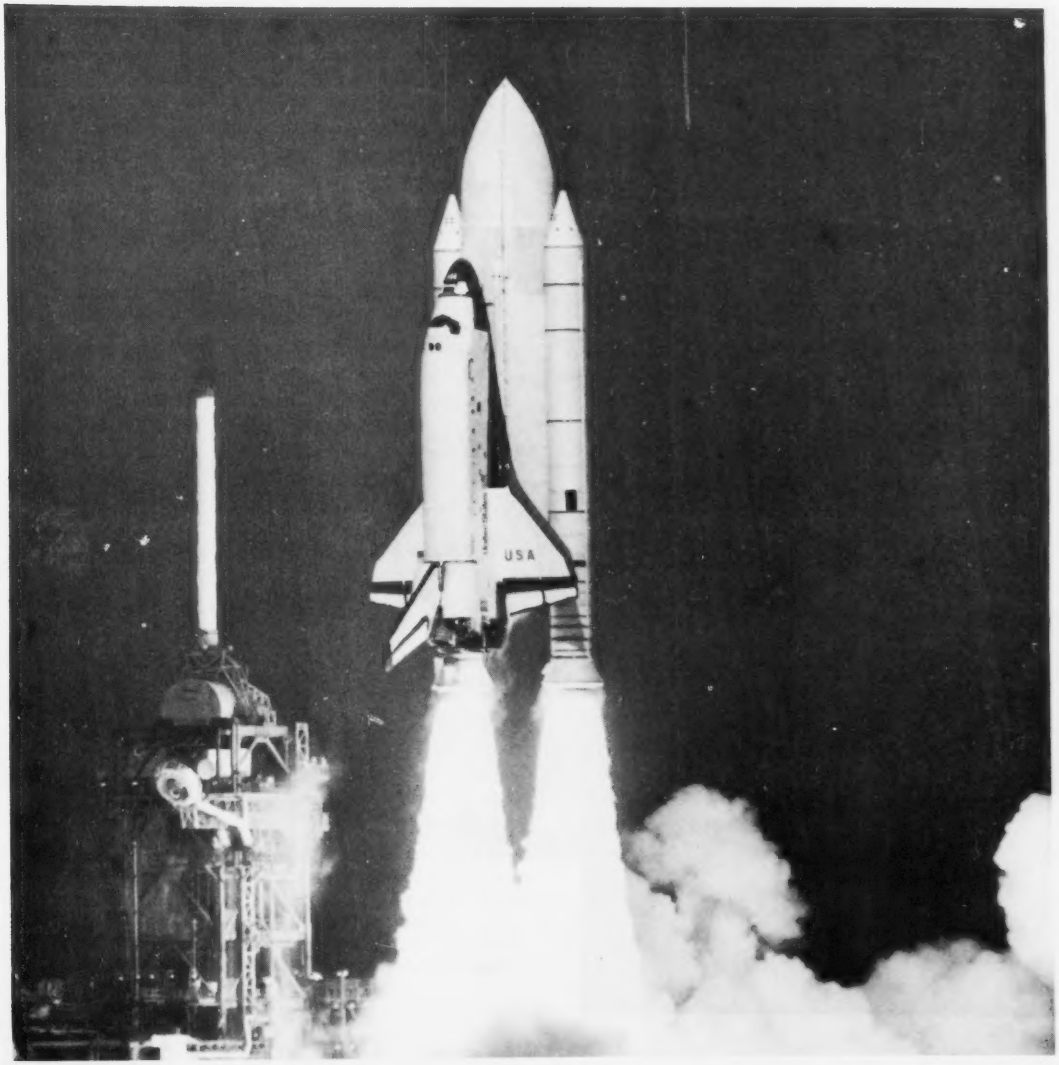
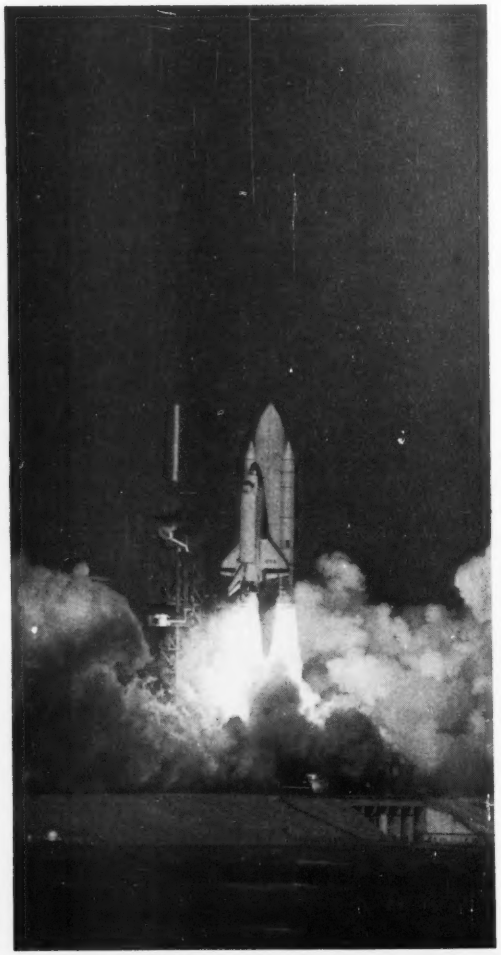


About the Cover

Space Shuttle Columbia lifts off Nov. 12 for its second journey into space and earth orbit—distinguished as the first manned spacecraft ever to return to space. Columbia was piloted by Joe Engle (commander) and Richard Truly (pilot).

Shown on the back cover is a spectacular shot of the underside of the Space Shuttle taken from the primary photo chase plane by astronaut Kathryn Sullivan. Piloting the T-38 chase plane was astronaut Robert Gibson.



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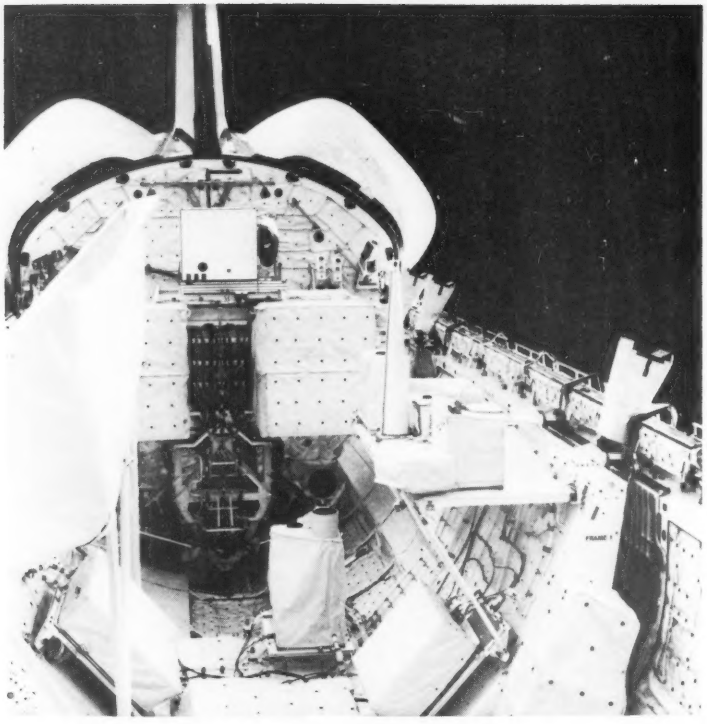
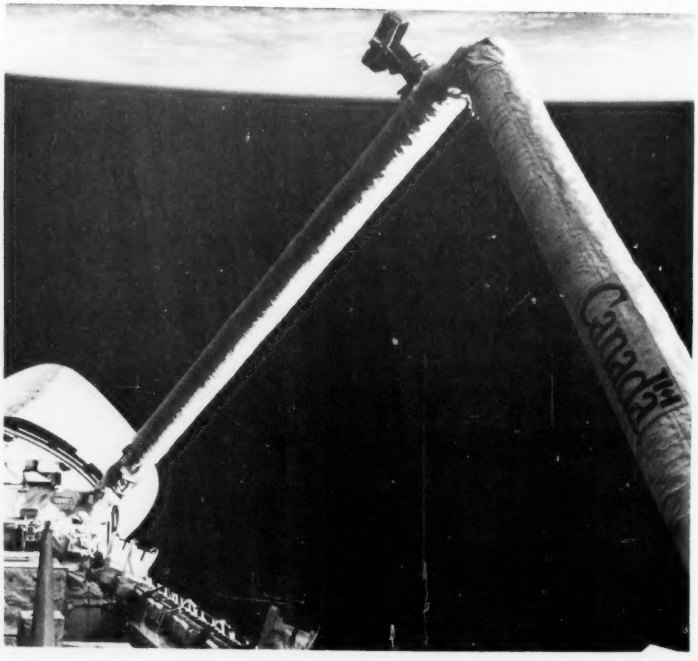
Crowds estimated at several hundred thousand people (by the Brevard County Sheriff's office) gathered on causeways surrounding NASA's Kennedy Space Center, Fla., to view the second launch of the Space Shuttle *Columbia* on Nov. 12. Official liftoff time was 10:09:59.887 a.m. EST. Weather for the launch was picture perfect, falling well within guidelines for launch: visibility greater than seven miles, scattered clouds at 25,000 feet and tailwinds and crosswinds between 10-15 knots.

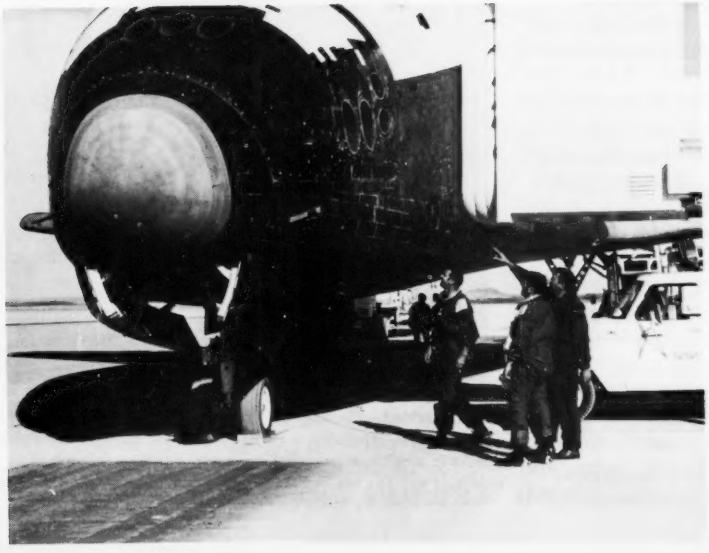


Essential to the second Space Shuttle mission, as for the first mission, was successful payload bay door tests—activation, opening, radiator deployment and closing of the doors. Payload bay door latch tests and radiator deployment were performed with complete success during the crew's first hours after launch. Shown is a crew photo of the cargo bay taken from inside the Shuttle cabin. In the foreground is the pallet bearing the Columbia's first payload of experiments, OSTA-1.



Onboard *Columbia* for its second flight was the Remote Manipulator System—a robot analogue of a human arm. The 15-meter (50-foot) RMS, donated by Canada to the U.S. space program, was designed and built by a Canadian industrial team under prime contract from the National Research Council of Canada to Spar Aerospace, Ltd. Its principal use will be to deploy and retrieve satellites from/to the orbiter's cargo bay. During this second flight, primary mission objectives were to test the arm in all of its operational modes, both automatic and manual, exclusive of its grappling feature. The arm performed flawlessly. Shown is a crew photo of the Remote Manipulator System taken from a 70-mm hand-held camera.

Touchdown II of *Columbia* on Runway 23 at Edwards Air Force Base, Calif. Mission elapsed time for STS-2 was 2 days, 6 hours, 13 minutes and 10 seconds. Although the second mission of *Columbia* was an abbreviated one due to onboard problems with one of the orbiter's three fuel cells, STS-2's mission was declared a success with 100 percent of all essential data collected and 90 percent of total mission data collected.



STS-2 crew Joe Engle and Richard Truly look over *Columbia's* tiles after touchdown on Nov. 14. Inspections conducted immediately after landing showed none of the tiles were lost and surface damage was minimal.

Biology Experiment Planned for Third Shuttle Flight

The third flight of NASA's Space Shuttle, scheduled for launch no earlier than March 1982, will carry the first biology experiment designed for Shuttle flight. The experiment will study the effect of gravity on the formation of lignin in plants. Lignin is the woody substance that gives plants their structural stability.

By watching seedlings grow in the microgravity environment of space, scientists expect to learn more about lignin synthesis and how wood is formed. Scientists believe that the plants will grow upward in response to the attraction of the growth unit's artificial sunlight, despite a lack of gravity. But as roots are less responsive to light, scientists are unsure how the roots will grow.

The orbiting greenhouse will be closely monitored; researchers will be able to tell whether growth directions varied under light or nighttime conditions and thermostat control will guard against possible fluctuations in the spacecraft temperature. Information will focus on changes in growth patterns, and on the relationship between growth and lignin production.

"It may be that the roots grow virtually in any direction while the sprouts turn towards the light regardless of the germinating seeds' original position," says Dr. John Tremor, project manager, Ames Research Center, Mountain View, Calif. "We've never been able to maintain a zero-gravity environment long enough to run such a test, so it's hard to say what we expect. However, the Russians have reported that shoots and roots grown under weightless and dark conditions have grown along the lines determined by the seeds' original placement on the medium."

Principal investigator, Dr. Joseph Cowles, University of Houston, hypothesizes that in space plants will respond to the lack of gravity by manufacturing less lignin. Regulating lignin production has significant economic value. Although lignin is vital to producing the wood of trees, for instance, it is considered a nuisance in some applications; it must be removed before conversion of certain wood products into paper and plastics, and it competes with food production in many plants.

This information may also someday be useful to space colonizers who will need to know plant growth patterns under weightless conditions and how to maximize the food they grow.

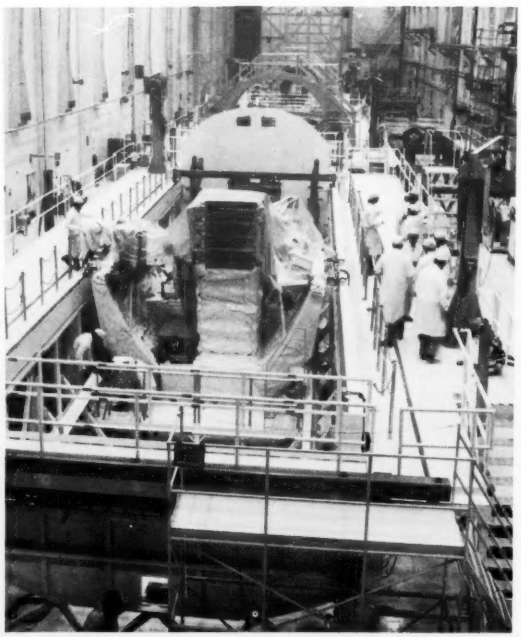
The experiment itself will occur in a breadbox-sized plant growth unit containing six 25-centimeter (10-inch)-high plant growth chambers which resemble thin, rectangular terrariums.

The six receptacles, built from aluminum and a special heat-resistant polycarbonate material, will house two rows of eight seeds each, in sandwiches of moist sponge and filter paper. There will be oat and bean seeds and pine seedlings which have already been germinated (pine sprouts take more time to germinate than the Shuttle mission will provide).

During the Shuttle's seven-day sojourn in Earth orbit during its third flight, the six chambers will receive 14 hours of artificial sunlight from sunlamps each day.

"When the Shuttle lands," says Tremor, "the sprouts will be taken out for examination immediately—possibly even before the astronauts are out."

Construction of the NASA Ames plant growth unit, which has been specially designed to meet the weight, space power and safety requirements of Space Shuttle payloads, was completed in October 1981.



Next Payload—The OSS-1 (Office of Space Science-1) package of experiments, scheduled to fly as the payload for the third Space Shuttle mission, is inspected in its workstand—a mockup of the Shuttle payload bay in the Operations and Checkout Building at NASA's Kennedy Space Center, Fla.

Voyager 2 Discovers Hot Plasma Zone Near Saturn

Space scientists, using data collected by NASA's Voyager 2 during its flyby of Saturn this past August, have found a place in the solar system containing the hottest gas yet observed. Temperatures in a region around Saturn range from 600 million to over 1 billion degrees Fahrenheit. The observation was recorded by Voyager 2's Low Energy Charged Particle experiment.

The hot gas is an enormous doughnut-shaped region encircling Saturn at an altitude ranging from 273,600 kilometers (170,000 miles) above the planet's cloud top to as high as 724,000 km (450,000 mi.), an area that seems to be centered around the orbits of Dione and Rhea, two of Saturn's icy moons, and to extend further away from the planet on the dayside than on the nightside.

The temperatures are about 300 times hotter than the solar corona, and twice as hot as the Jupiter plasma cloud discovered by Voyager in 1979 (a plasma is a gas consisting of electrified particles called ions and electrons).

Voyager 2 survived passage through this region because the density of the hot gas is very small—only about 30 particles in a cubic foot; therefore there were not very many ions hitting the spacecraft and heating it up.

Scientists explain that it is very important in such studies to understand the relationship between density and heat. For example, sticking one's finger in a hot oven momentarily does not produce any burns, but placing the finger in water at the same temperature can produce severe burns. The density is the difference, since atoms in an oven are not as densely packed as those in water.

The Low Energy Charged Particle instrument is designed to measure fast (a few thousand miles per second) ions and electrons in the magnetospheres of the planets and in the interplanetary medium. The instrument can distinguish several elements such as hydrogen, helium, oxygen, sulfur, sodium and others, measure the direction in which these high speed particles are moving and the temperature of this particle population when the plasma is very hot (tens of millions of degrees). The instrument is also capable of identifying the equivalent of the Van Allen belts and radiation zones in the magnetosphere of the planets.

This hot plasma region had been previously identified by Pioneer 11 and Voyager 1 experiments as relatively "cold" plasma (temperatures of a few million degrees), a thousand times denser than the hot plasma identified by Voyager 2. Scientists have not offered any obvious explanation for the heating mechanism of this gas.

Dr. S. M. Krimigis, chief scientist of the Applied Physics Laboratory Space Department, The Johns Hopkins University, Baltimore, Md., is principal investigator of the Voyager Low Energy Charged Particle experiment. Other scientists participating in the analysis included Drs. J. F. Carbary, E. P. Keath and E. C. Roelof of The Johns Hopkins Laboratory, Dr. D. C. Hamilton of the University of Maryland and Dr. W. I. Axford of the Max-Planck Institute for Aeronomy in Lindau, Germany.

New Theory on Origin of Solar System Bodies

Findings of two scientists at NASA's Ames Research Center, Mountain View, Calif., are helping to change scientific thinking regarding the origin of the solar system.

Previously, the solar system was thought to have originated from part of a huge, thin and cold cloud of interstellar matter that contracted into a more dense uniform cloud of hot gases and dust called the solar nebula. As the solar nebula cooled, mineral grains formed by condensation. The dust and grains aggregated into small, solid bodies; and these so-called planetesimals were consolidated into the planets, moons, comets and asteroids.

According to this theory, the first formed planetesimals of the solar system should contain roughly the same proportions of the rock-forming elements as are found in the Sun. Earlier studies found such a similarity in a special class of meteorites called carbonaceous chondrites, once considered by scientists to be primitive or unchanged examples of these first formed planetesimals.

But recent findings of the two Ames researchers revealed that these chondrites were not primitive but in fact had gone through chemical changes.

The findings by Dr. Theodore Bunch and Dr. Sherwood Chang open the doors to new ideas about the origin of these meteorites and, therefore, about what happened in the earliest stages of the origin of the solar system.

The rocky pieces of matter that hold the clues to the origin of the solar system are called carbonaceous chondrites because they contain the element carbon, one of the building blocks of life. They also contain other building blocks—hydrogen,

nitrogen and oxygen—and complex organic molecules. They are among the oldest rocks yet discovered, some being 4.65 billion years old.

The researchers found at least three different kinds of clays in the carbonaceous chondrites. The conventional theory hypothesized that these clays formed by reactions between gas and dust in the solar nebula prior to consolidation into small bodies. However, the clays show no evidence of this gas/dust origin.

Instead, evidence indicates they formed in ways similar to those of some clays on Earth. (In some Earth environments, water reacts with some water-free minerals to form clays. The water dissolves and transports some minerals away, leaving clay minerals in their places.) These sorts of processes could only have occurred on the parent body of the meteorite (the body the meteorite broke away from)—perhaps, on a comet or asteroid—and could not have occurred in the solar nebula gas/dust cloud.

The three different clays also had three different chemistries. If the solar nebula theory were true, the clays should have more or less a uniform chemical composition. The differences in the clays could be readily explained, however, by the action of water on the minerals in the surface of a small body.

The two researchers now believe the carbonaceous chondrites probably broke away from asteroids or comets after this process had taken place. Thus the chondrites are not unchanged, primitive samples of the past. This raises the possibility that the water and some of the water-soluble material, including organic compounds, in these meteorites were originally formed in interstellar space before the origin of the solar system. (This possibility requires that they were never evaporated in the solar nebula and managed to survive the processes of consolidation.)

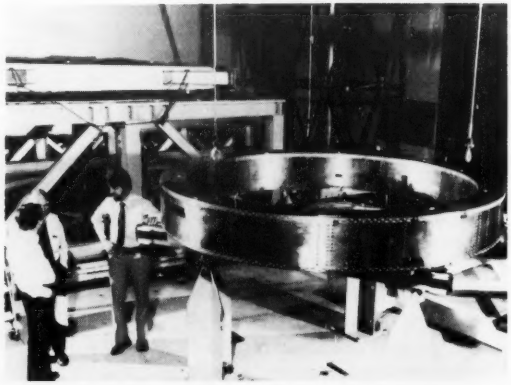
Thus, scientists, through the study of carbonaceous meteorites, may be able to look backward in time and determine what was occurring in interstellar space before the solar system was beginning to form, more than 4½ billion years ago.

Bunch and Chang suggest a new model labeled the "cosmic raisin muffin" model. In this model, when the solar system was forming, the bodies that aggregated at great distances from the Sun in the very low temperature regions—possibly comets—were composed mostly of ice mixed with rocky material and dust. Nearer the Sun, as close as the outer regions of the asteroid belt, the carbonaceous meteorites formed. They were made of mostly rocky matter with chunks of ice imbedded in them like raisins.

In many of the carbonaceous chondrites, the clays surround small regions of unchanged, relic material. The two scientists theorize that the parent body, aggregated from both rocky and icy building blocks, was heated, causing the ice to melt and the water to react with rock minerals forming the clays. For some reason, perhaps a cooling of the parent body or insufficient water, alteration of the rocky matrix was incomplete, leaving relic islands of rocks.

Work by other researchers supports the new model. Scientists discovered the decay products of aluminum 26, a radioactive isotope of aluminum, in carbonaceous chondrites. (An isotope of an element contains the same number of protons, but a different number of neutrons, giving it a different atomic weight.) It is possible that the heat caused by the decay of this isotope could have melted the ice in bodies consolidated in the low temperature regions of the solar system. Chemical reactions involving the resulting water could have formed the clays discovered in the carbonaceous chondrites.

Bunch and Chang also theorize that during the aggregation of solid matter into asteroid-sized bodies (tens to thousands of kilometers in diameter), the associated collision of building blocks with the growing bodies could have produced enough heat to melt the ice.



Space Main Frame—The Space Telescope's "main ring" which houses the primary mirror of NASA's optical observatory arrived at Marshall Space Flight Center, Huntsville, Ala. in November. The ring was supplied by Exelco Corp., a Perkin-Elmer subcontractor in Silver Creek, N.Y. With arrival of the main ring, most of the major components of the Optical Telescope Assembly now can be fitted into a unified structure. The Space Telescope is managed by Marshall.

NASA and German Ministry Plan Cooperative Mission

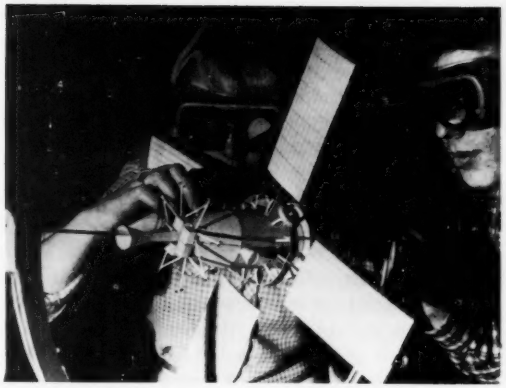
NASA Administrator James M. Beggs and Dr. Andreas von Buelow, Minister for Research and Technology (BMFT) of the Federal Republic of Germany, recently signed an agreement for a cooperative project to study the Earth's magnetosphere. The project, Active Magnetospheric Particle Tracer Explorers, will use two spacecraft to study Sun-Earth interaction through active chemical release.

Mission objectives are to perform detailed studies of how solar wind ions enter the Earth's magnetosphere and the processes by which these particles are energized in the Earth's magnetospheric tail—the elongated portion of the Earth's magnetic envelope which streams away from the solar wind. Tracer ions of lithium and barium will be released from the German Ion Release Module and will be measured in the solar wind and within the Earth's magnetosphere by the American Charge Composition Explorer.

Ions will be released in three places around the Earth—in front of the Earth's magnetosphere at the sub-solar point; alongside the Earth at the magnetosheath (the boundary layer between the Earth's magnetic envelope and the solar wind); and inside the distant tail of the Earth's magnetosphere. The use of different ions will enable the project to study both the composition and dynamics of the natural charged particle population within the Earth's magnetosphere.

To carry out this project, NASA and BMFT plan to develop and launch two spacecraft. NASA will provide the Charge Composition Explorer that will be launched in 1984 on a Delta launch vehicle into a highly elliptical orbit with an apogee of eight Earth radii. The German Ion Release Module will be launched on the same vehicle with an additional kick stage to place it in a highly elliptical orbit with an apogee of about 20 Earth radii. Ion releases will be made by the Ion Release Module and ions will be detected by the Charge Composition Explorer. Both sides will provide instrumentation. Ground observations will supplement the spacecraft data.

The NASA portion of the joint project is managed by the Office of Space Science, NASA Headquarters, Washington, D.C., and tracking support will be provided by NASA's Goddard Space Flight Center, Greenbelt, Md. The Johns Hopkins Applied Physics Laboratory, Baltimore, and the German Max Planck Institut fuer Extraterrestrische Physik, Garching, Germany, will also provide scientific support for the project.



Shadow Analyzers—Engineers at NASA's Marshall Space Flight Center, Huntsville, Ala., (Sally Little (left) and Don Ford) conduct a solar array sun shadow analysis on a model of the Gravity Probe-B satellite now under study at Marshall. The satellite is being designed to verify portions of Einstein's theory of relativity. The shadow analysis is used to establish data on the path that shadows take as they move across the solar arrays used to provide electrical power to the spacecraft. This data will then be used to determine the optimum configuration of the solar arrays to ensure they capture enough sunlight to maintain a continuous level of power throughout the year-long experiment.

Solar Max Satellite Detects New Reactions in Solar Flares

One of the instruments on NASA's Solar Maximum Mission satellite has detected several important new kinds of emissions from solar flares. The satellite, launched Feb. 14, 1980, continues its study of solar activity during the current maximum period of this 11-year sunspot cycle.

The observations were made by a gamma ray and neutron spectrometer instrument built at the University of New Hampshire under direction of Dr. Edward L. Chupp. Chupp reports that during a major flare on June 21, 1980, his experiment made the first clear observations of neutrons reaching the Earth from a solar flare.

Neutrons are neutral subatomic particles created in nuclear reactions with flares. Free neutrons decay spontaneously into protons and electrons in about 15 minutes, so only very high-speed neutrons can reach the Earth at all, as light takes about eight minutes to reach the Earth from the Sun.

In the June 21 flare an intense burst of gamma rays lasting about one minute was followed by a

20-minute stream of neutrons. This particular flare was probably the most intense to occur yet during this solar cycle.

In another flare on April 27, 1981, Chupp's instrument observed gamma rays with energies characteristic of several varieties of nuclear reactions theorized but never before seen on the Sun. These reactions are caused when protons moving at nearly the speed of light collide with other atoms in the solar atmosphere including nitrogen, silicon, magnesium, iron, lithium and beryllium atoms. This provides valuable clues concerning the abundances of different atoms in solar flares and the mechanism in which protons are accelerated to high speeds. A Japanese solar research satellite also observed this same flare and confirmed many features of the observations from NASA's satellite.

The gamma ray spectrometer experiment was built by United States and Federal Republic of Germany scientists working with Chupp.

The project scientist for the instrument development was Dr. David J. Forrest, University of New Hampshire. The German effort was headed by Dr. Claus Reppin, Max Planck Institute at Garching. The Naval Research Laboratory, Washington, D.C., is also assisting with data analysis, under Dr. Gerald Share.

The Solar Maximum Mission satellite is managed for NASA's Office of Space Science by the NASA Goddard Space Flight Center, Greenbelt, Md.

Space Meals—Closeup view of a Shuttle mid-deck locker tray containing 18 standard orbital test flight menu meals for two crew members.

Three Deep Space Network Antennas Shut Down

Three 26-meter (85-foot) tracking antennas operated by the NASA Deep Space Network at Goldstone, Calif.; Madrid, Spain; and at Honeysuckle Creek near Canberra, Australia, ceased operations on Dec. 1, 1981, because of reductions in NASA's operating budget and the modestly declining workload of the network.

The stations will continue to operate 64-m (210-ft.) and 34-m (112-ft.) deep space tracking antennas as in the past.

Ending operation of the 26-m antennas causes a reduction of about 30 percent of the Deep Space Network tracking and data-acquisition capability. This means less support for NASA planetary spacecraft. Currently the Deep Space Network is supporting Voyagers 1 and 2, Helios 1, and Mars Viking 1 Lander and Pioneers 6 through 12.

It is estimated that terminating operation of the three antennas will result in savings of about $7.2 million per year beginning in Fiscal Year 1983. Reductions totaling 110 positions are involved in the termination, including 51 in Spain, 26 in Australia and 33 at Goldstone.

The stations in Spain and Australia are operated by government agencies of those countries. The reductions in both countries are expected to be achieved by reassignment and attrition. The Goldstone station is operated by the Bendix Field Engineering Corp. Bendix also expects to achieve its reduction largely through reassignment and attrition.

The Deep Space Network is managed for the NASA Office of Tracking and Data Systems by the Jet Propulsion Laboratory, Pasadena, Calif.

Solar Cell Systems Used In Third World Projects

Solar cell systems, which have powered many NASA spacecraft, are now being considered for experimental applications in rural areas of developing nations. Experience gained with these applications will assist in developing large-scale, low-cost solar energy systems for use in the United States.

Over the next two years, solar cell systems will be installed in the African countries of Gambia, Ivory Coast, Tunisia, Kenya, Gabon and Zimbabwe; the South American nations of Colombia, Peru,

Ecuador and Guyana; and in India and the Maldive Islands in the Indian Ocean. The installations in Kenya, Zimbabwe, Ecuador and Guyana will involve, for example, the electrification of medical centers.

Typical is the Ikutha Health Center located in a semi-arid Kenya region 250 kilometers (155 miles) southeast of Nairobi. By late 1982, the village's eight-room medical center, serving some 65 patients daily, will have an operational photovoltaic/electric system to provide refrigeration to preserve life-saving vaccines as well as power for lighting, sterilizer operation and two-way radios.

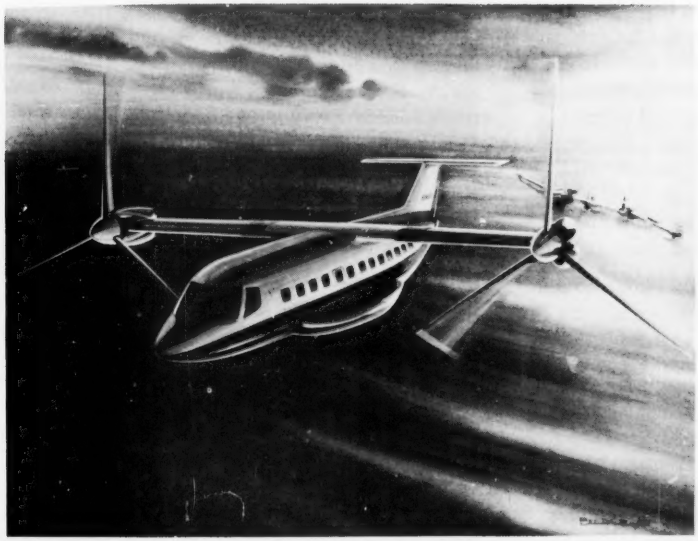
A somewhat more ambitious project is slated for the Tunisian village of Hamman Biadha, 130 km (80 mi.) southwest of Tunis. Funded jointly by the Agency for International Development and the government of Tunisia, a village photovoltaic system of about 25 kilowatts will be installed along with a number of small wind, solar heating and photovoltaic powered-irrigation systems. These systems are scheduled to be operational in the fall of 1982.

In the West African village of Tangaye, Upper Volta, farming and cattle raising are the main occupations and the milling of grain and the drawing of water are two laborious and time-consuming tasks heretofore performed by hand. Now, at Tangaye, photovoltaic electric systems designed at NASA's Lewis Research Center in Cleveland, power a water pump and drive a commercial hammermill; and the women of the village are relieved of this work to have more time for family care.

The Tangaye photovoltaic system recently was enlarged, increasing the system's power output from 1.8 peak watts (wp) to 3.6 wp by doubling the square footage of the solar cell arrays. The expansion of this system represents the first field demonstration of another of solar cell system's major advantages—modularity; for more energy capacity, merely add more solar cells.

William J. Bifano, manager of the Photovoltaic Project Office of NASA's Lewis Research Center, Cleveland, explains the current program emphasis abroad: "For photovoltaic-produced electricity to become a major factor in America's energy arsenal, private industry must produce solar cell and ancillary equipment in high volume. Only through advanced technology and mass production techniques will the cost of photovoltaic power be reduced to the point where this energy can help meet the nation's future energy needs.

"Right now, photovoltaic electricity is cost-effective only in remote areas where it doesn't com-



Commerical Tilt Rotor—Artist's concept of civilian use of Tilt Rotor aircraft design based on the NASA/Army XV-15 tilt rotor experimental aircraft. The XV-15, developed and built for NASA by Bell Helicopter Textron Company in Texas, has been test flown by NASA and Army test pilots of NASA's Ames Research Center, Mountain View, Calif., and Dryden Flight Research Facility, Edwards, Calif. The advantage of the tilt rotor design is its ability to rise and land like a helicopter with its wing tip engines rotated to the vertical or to fly more economically and faster in forward flight with its engines rotated to the horizontal.

pete with less expensive utility-produced electric power.

"Besides being in dire need of refrigeration, light and power, the millions of isolated villages in developing countries represent a potentially vast market for photovoltaic systems—one that could lead us into the age of mass-produced photovoltaic hardware."

The experimental solar cell systems will supply electricity at sites generally requiring less than 6,000 kilowatt hours annually. Such applications now depend on conventional diesel-electric systems, which are expensive owing to three factors: high fuel costs (often more than $3 per gallon), operation of the diesel engine below its capacity, where the unit is less efficient, and high maintenance and repair costs. As a result, the cost of electricity often approaches $2 per kilowatt-hour or more, about the same as solar cell derived electricity today, assuming life-cycle costing.

Programs sponsored by the Department of Energy have reduced the costs of solar cells in recent years. Today a solar cell module can be purchased for about $10 per watt compared to $30 per watt a few years ago.

NASA's Lewis Research Center manages projects which deploy solar cell electricity systems overseas for the Department of Energy (DOE) and the Agency for International Development (AID).

The DOE portion is developing the technology for reliable operation of complete solar cell systems and deploying them in real life situations. The AID program is experimenting with different uses of solar cell systems in selected, remote sites so that, when the costs drop, AID, in conjunction with Third World countries, can determine from experience how best to make widespread use of solar cell systems.

Since 1976, NASA Lewis has installed 18 experimental systems in the United States plus one now operating in Upper Volta. A significant U.S. installation is the world's first solar cell village power system, located on the Papago Indian reservation in Schuchuli, Ariz. This 3.5-kw system has been operational since December 1978.

Did You Know?

Honeywell's Electro-Optics Operations, Lexington, Mass., recently dedicated its **new Space Systems Center**. The 100,000 square-foot building contains engineering, manufacturing and test operations for spaceborne sensors developed by Electro-Optics for NASA-sponsored upper atmospheric research and space applications.

The how and why of wind tunnels and their significant role in advancing the nation's military and commercial aviation is described in a new NASA publication, *Wind Tunnels of NASA*. NASA's experience with wind tunnels forms the basis for the book but facilities of the Air Force, universities and industry also are covered and the tunnels of other countries are assessed to some extent. This 164-page illustrated publication is for sale for $12.00 by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Dr. Donald N. B. Hall has been appointed as **Deputy Director** of the **Space Telescope Science Institute,** Baltimore, Md. Hall has been an astronomer at the Kitt Peak National Observatory in Tucson, Ariz., since 1970 and currently holds the position of Astronomer with Tenure. Hall heads the Next Generation Telescope and Gratings Laboratory efforts at Kitt Peak and has held a broad range of administrative posts within the Observatory. In 1977, Hall received the American Astronomical Society's Newton Lacey Pierce Prize.

Twenty-five life sciences flight experiments have been selected for **Spacelab 4** in the fields of cardiovascular adoption to zero gravity, human protein metabolism during spaceflight and gravitropic response of plants. Detailed design is underway on this integrated science payload. In addition to the design of hardware unique to this mission, an inventory of reusable flight biological laboratory equipment is being fabricated for use on this and future flights. Spacelab 4 is scheduled for launch aboard the Space Shuttle no earlier than 1985.

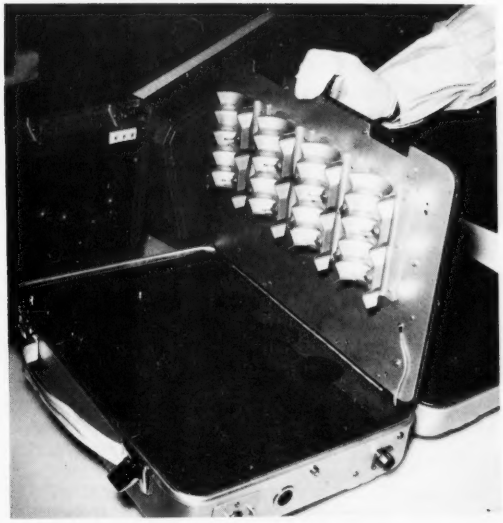
Joseph W. Stickle has been selected to head the **Low-Speed Aerodynamics Division** at NASA's Langley Research Center in Hampton. He was formerly acting chief of that division. The Low-Speed Aerodynamics Division plans, develops and conducts analytical, wind tunnel and flight research programs on aeronautical technology with emphasis on subsonic aerodynamics, flight dynamics, operating efficiency and flight environment. The division maintains and operates the center's fleet of 18 research and support aircraft and manages the operation of the 4 by 7 meter tunnel, the full-scale tunnel, the spin tunnel and the vortex research facility.

Lewis Research Center's open house held in October set a new visitor record—18,000 visitors in two

days. Lewis' public affairs office noted that the Center's open house and month-long program with the Cleveland Museum of Natural History drew wide media coverage in Cleveland papers, local television and radio. These events were a part of the Lewis 40th Anniversary celebration.

Doing Business in Space: Legal Issues and Practical Problems, an international conference, was held in Washington, D.C., in November under the sponsorship of the American Law Institute-American Bar Association Committee on Continuing Professional Education, the International Bar Association (in London) and the Smithsonian Institution. The conference, described as "an intensive working seminar," focused on the international and domestic laws of various nations that affect non-governmental interests carrying out or planning to do business in space. The emphasis will be on uncovering problems, outlining them and attempting to offer solutions. Topics discussed included: "Space Activities of Private Industry: Applicability of the Outer Space Treaty of 1967 and the 1971 Convention on International Liability for Damage Caused by Space Objects," and "INTELSAT's Other Half: The Global Systems Earth Segment." Also included were seminars on "International Cooperation in Commercial Space Launching Operation" and on "Structuring a Risk Management Program in a Changing Insurance Market." For further information on this seminar, contact: Robert Federico, ALI-ABA International Conference on Doing Business in Space, 4025 Chestnut St., Philadelphia, Pa. 19104; (215) 243-1630.

Idea Clearinghouse cites NASA's Jet Propulsion Laboratory, Pasadena, Calif., for developing a program in their reliability engineering section for monitoring equipment maintenance. The heart of the program is the computerized monthly maintenance status report which assures that each of some 3,000 pieces of equipment gets adequate visibility. A designated individual can determine the location of the equipment, the nature of the item being checked, and how long it took to maintain last time or on a cumulative "to date" basis. The status report serves as an automated inventory list as well as a schedule for monitoring equipment maintenance. The program entitled "Maintainability Program for the Environmental Test Areas" was initiated in December 1980 and has been operational since April. Results have been good, with much less equipment downtime experienced. If you want to learn more about applying this program for your own use, call Don Elliott (JPL) at FTS 792-6220 for a detailed description.



Shuttle Food Warmer—Closeup view of a Space Shuttle food warmer used by crew members on the orbital flight tests. Beverage packages (cocoa, coffee, and tea) are heated on the side of the center plate. The packages are held in place by small cip/springs. Canned foods fit into the round circles that are cut in the foam insulating material and the bottom is on contact with the heated plate.

First Steps Toward Shuttle Processing Contract Announced

Representatives of companies that are interested in bidding on a future contract to do all Shuttle processing for NASA have been invited to watch the complete cycle of preparation of the Space Transportation System for its third mission.

Qualified companies have been invited to assign a limited number of their own managers and engineers to observe and assess the steps required from the time the orbiter returns to Kennedy after its second trip in space until it is returned after its third mission early in 1982. The group of observers will have no active role and no official responsibility for Shuttle processing operations.

The invitation is an effort to give potential bidders every opportunity to learn what it takes to prepare

the Shuttle for flight in order to assure knowledgeable competition when NASA solicits proposals for a Shuttle Processing Contract next fall.

The new contract will cover refurbishment after flights of Space Transportation System orbiters in preparation for their next missions, checkout and assembly of the other elements of the Space Shuttle such as the external tank and solid rocket boosters, and responsibility for support operations and materials, including maintenance and operation of facilities.

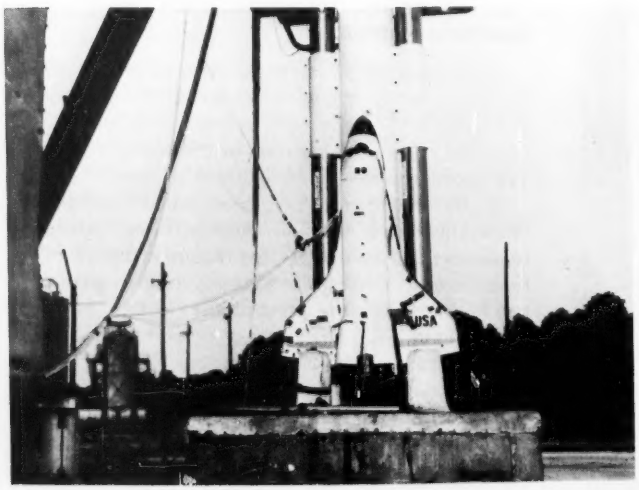
The Shuttle Processing Contract is the second of three comprehensive contracts that NASA intends to establish at Kennedy as the most effective and economical method of conducting Shuttle missions when the system becomes operational subsequent to the first four developmental flights. The first contract, covering base operations, or institutional support services, is scheduled to be awarded about one year from now. The third, the Cargo Processing Contract, is not currently scheduled but is intended to follow the other two.

Using the experience of industry representatives observing the processing of the Space Shuttle for its third mission, NASA plans to develop a statement of work for release next fall. About nine months will be allowed for proposals, evaluation and negotiation of a new Shuttle processing contract. A six-month transition period is planned to permit orderly turnover after the contract is awarded in the summer of 1983. If the schedule holds, the contractor will begin full operations at the beginning of 1984.

Contractor News

Hughes Aircraft Co., Space and Communications Group, El Segundo, Calif., has been selected by NASA's Jet Propulsion Laboratory, Pasadena, Calif., for negotiations leading to a contract for the Synthetic Aperture Radar (SAR) system for the Venus Orbiting Imaging Radar (VOIR) mission. An initial contract will call for continuing studies of the SAR design and is valued at $1 million covering a period of about six months effort. Launch of the VOIR spacecraft is scheduled for 1988.

General Electric Co., Space Systems Div., Sunnyvale, Calif., has been selected by NASA's Ames Research Center, Mountain View, Calif., for final negotiations of a contract for integration support services for the proposed Numerical Aerodynamic Simulator, a specialized supercomputer currently being studied. which may process data 40 times faster than existing supercomputers, with a high speed memory 60 times larger than the currrent generation of supercomputer. The contract will be a cost-plus-award-fee with a proposed estimated amount of $6.7 million for the basic 28-month contract and a first 12-month option period. The Numerical Aerodynamic Simulator will be used in the research and development of new aircraft and other flight vehicles and for research in fluid flow areas such as meteorology, gas dynamics and computational chemistry.



Overpressure Problem Solver—Scale model at 6.4 percent size of the Space Shuttle and scaled down Mobile Launch Platform that was used at NASA's Marshall Space Flight Center, Huntsville, Ala. to develop and prove out a way to reduce excessive overpressure experienced during the first launch of the Shuttle in April. A water spray concept combined with water troughs significantly reduced the overpressure for the November launch.

Expendable Launches for 1981

Name	Launch Date	Vehicle	Range	Mission Remarks
*COMSTAR-D	February 21	Atlas Centaur	ESMC	Comsat General Corp. communications. Reimbursable.
*Navy 20 (NOVA 1)	May 15	Scout	WSMC	DOD transit. Reimbursable.
*GOES-E	May 22	Delta	ESMC	NOAA weather. Reimbursable.
*Intelsat V-B	May 23	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.
*NOAA-C	June 22	Atlas-F	WSMC	NOAA weather. Reimbursable.
*Dynamics Explorer	August 3	Delta	WSMC	NASA scientific.
*FLTSATCOM-E	August 6	Atlas Centaur	ESMC	DOD communications. Reimbursable.
*SBS-B	September 24	Delta	ESMC	SBS communicatons. Reimbursable.
*Solar Mesosphere Explorer	October 6	Delta	WSMC	NASA scientific.
*RCA-D	November 19	Delta	ESMC	RCA communications. Reimbursable.
Intelsat V-C	December 9	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.
Navy 21 (NOVA 2)	4th quarter	Scout	WSMC	DOD transit. Reimbursable.

*Successful launch

Space Shuttle Launches for 1981

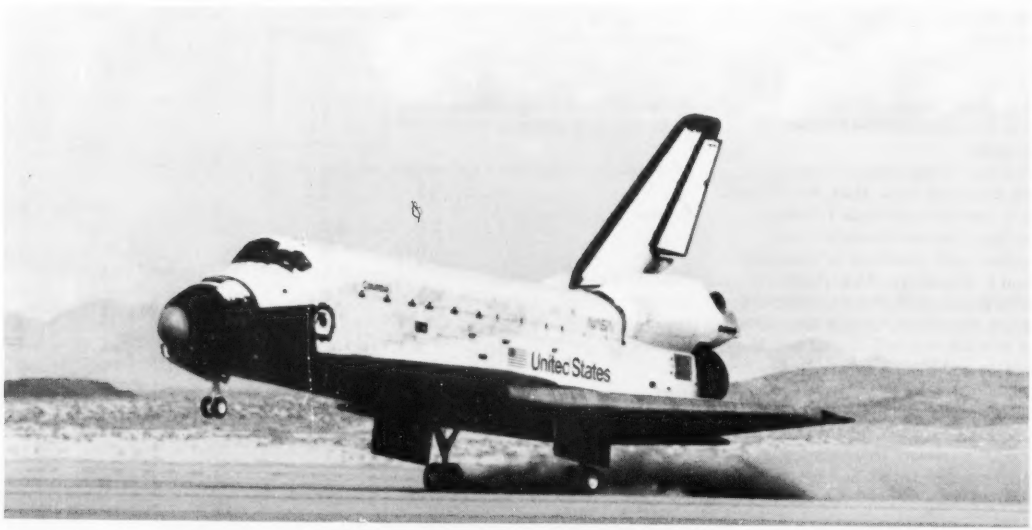
Orbiter	Launch Date	Launch Site	Payload
*Columbia (OV-102)	April 12	KSC	
*Columbia (OV-102)	Nov. 12	KSC	OSTA-1 DFI (with IECM)

Patents for Inventions from NASA Research

The office of General Counsel, NASA Headquarters, announces that the following U.S patents have been issued by the U.S. Patent and Trademark Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicated installation.

Inventor(s) & Employer	Title	Patent No.	Installation
John W. Edwards and John W. Smith, NASA/DFRF	Apparatus for damping operator induced oscillations of a controlled system	4,298,883	DFRF
James K. Niswander and Raymond J. Stattel, NASA/GSFC	memory-based frame synchronizer	4,298,987	GSFC
James A. Black, NASA/DFRF	Power converter	4,298,926	DFRF
James A. Munford and John G. Etzel, NASA/GSFC	Laser measuring system for incremental assembles	4,299,492	GSFC
Russell J. DeyYoung, Miami University, Oxford, Ohio, and Frank Hohl, NASA/LaRC	Large volume multiple-path nuclear pumped laser	4,300,106	LaRC
Robert F. Hummer and Deane T. Upton, Hughes-Santa Barbara Research Corp., subcontract under University of Wisconsin	Scanner	4,300,159	GSFC
Willibald P. Prasthofer, NASA/MSFC	Controlled overspray spray nozzle	4,330,723	MSFC
Frank W. Burcham, Jr., NASA/DFRC	multiple pure tone elimination strut assembly	4,300,656	DFRF
Houston D. McGinness, Caltech/JPL	Improved suspension system for a wheel rolling on a flat tract	4,301,740	NRO/JPL
Franklin W. Booth and Robert A. Bruce, LaRC	Air removal device	4,302,223	LaRC
Donald J. Stockton and Russell W. Johnson, Ball Corp., Boulder, CO	microwave switching power divider	4,302,734	GSFC

*U.S. GOVERNMENT PRINTING OFFICE : 1981 0-361-563/106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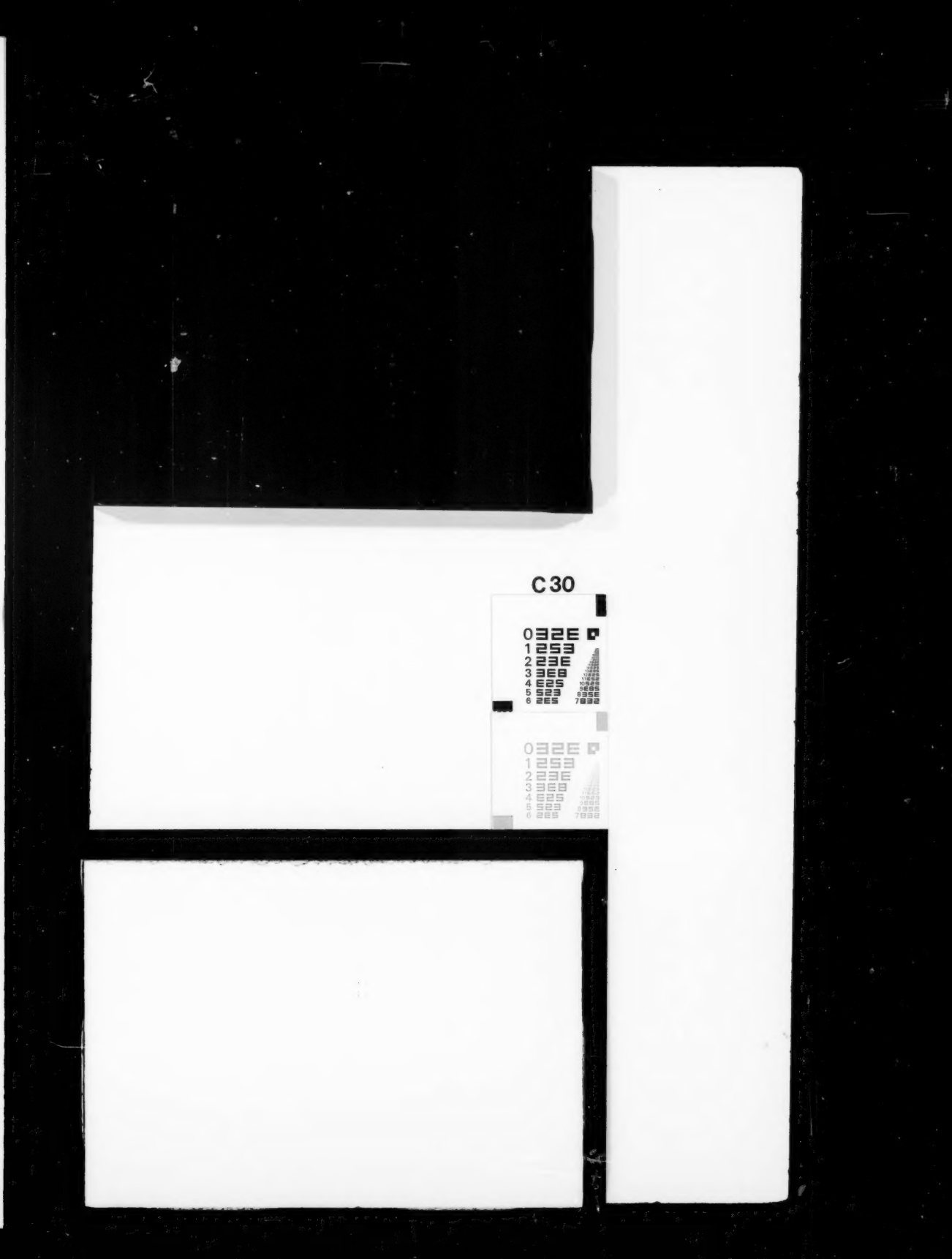
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